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Lubrication

A Technical Publication Devoted to the Selection and Use of Lubricants

THIS ISSUE

Automotive Production Machinery

Lubrication a Vital Factor in Machine Tool Operation

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Automotive Production Machinery

Lubrication a Vital Factor in Machine Tool Operation

THE tendency of the average man to evince a more than passing interest in the manufacture of the articles which lead to his increased comfort, pleasure and prosperity has been a marked transition in recent years. It is, therefore, practicable to appeal to him today in more technical terms, for he has a basic understanding of the science of engineering, and the benefit which will accrue to him in the use of this knowledge when he buys a mechanical article such as a motor car, washing machine or any of the other labor-saving devices so common in the lives of us all.

As a result, we have learned to visualize the magnitude of the work involved in the production of those articles which especially enhance our comforts and in turn relieve us of the arduous duties which but a generation ago were regarded as all in the course of the day's work.

Automotive transportation is perhaps the most outstanding in this regard. Therefore, when we speak of mass production in the automotive industry we think of thousands of new cars per day, of endless conveying mechanisms, of machinery capable of functioning in robot-like manner, whether or not an attendant is at hand.

The development of us as a motor-minded people has necessitated this application of the principles of mass production more completely to the automotive industry than to any other phase of manufacture. In consequence, the pride which the automotive industry takes in its advancement, and the part which it has played in promoting the welfare, comforts and pleasures of mankind is entirely justified.

Back of all this, however, has been the machine tool industry, and, to an equal degree, the petroleum industry.

Just as the automotive industry is dependent upon the machine tool industry for the machinery which has made possible its adoption of mass production methods, so is the latter industry dependent for the very life of its machinery, upon lubrication. The petroleum industry can justly claim, therefore, a part of equal importance in this revolution of production methods.

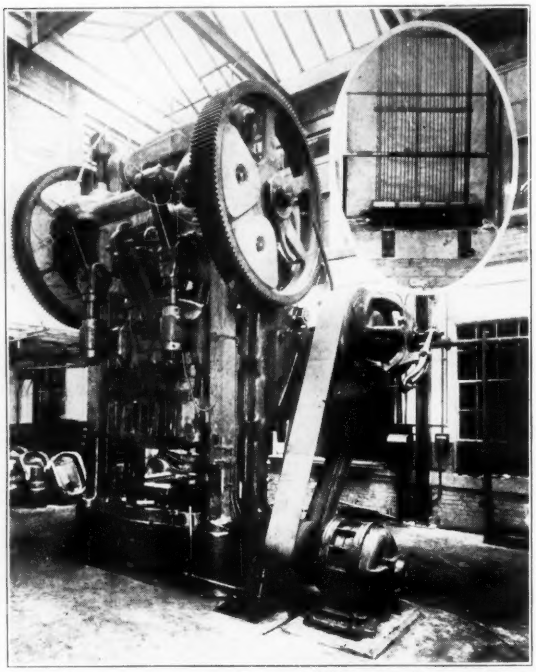
It is important to remember that mass production is distinctly a matter of perfect synchronization of machine operations. Obviously it would fail were any unit to become inoperative or function out of tune with respect to those adjacent. In the interest of assured continuity of production, it is the duty of the operators to guard against impending trouble rather than to control the actual operations of their respective machines.

In this regard, they are materially aided by the use of automatic lubrication, whereby the human factor in actual application of oils or greases is almost entirely eliminated.

The trend towards automatic lubrication of machine tools pertinent to mass production has been a natural sequence to the development of such machinery, for dependability in operation can be directly measured by the degree to which wear is prevented and friction reduced. So, manual methods of lubrication soon proved

to be inadequate. Furthermore, they involved a certain amount of hazard which increased in proportion to the speed, or the relative location of the parts to be lubricated.

In succession the mechanical force feed lubricator, pressure circulating systems built



Courtesy of McCord Radiator & Mfg. Co

Fig. 1—Showing a Ferracute Toggle Press equipped with a mechanical force feed lubricator. The particular advantages of the latter are claimed to be visibility, ease in flushing and positiveness of action.

into the machinery itself and centralized pressure devices have been adopted for distribution of oil; the pressure grease gun, spring type grease lubricator, or central control system being adopted where grease lubrication is desirable.

As an example, the accuracy of production required from grinding machinery has necessitated the most careful study in this regard, with the result that such equipment today is outstanding in the variety of automatic means employed for lubrication. Essentially, the grinding machine is oil lubricated with the exception of the table-ways on certain types, where provision is made for grease gun lubrication. Oil, however, is applied in a variety of ways; the screw feed, for example, is bath lubricated; the spindle, normally a mechanism operating at comparatively high speeds, being pressure lubricated in many machines, by means of a direct connected or chain driven gear pump. Certain table operating parts in turn in air controlled machines receive oil via the air used for operation through an air line lubricator, while the table-ways have been found to be admirably served by means of a type of force feed circulating system of lubrication.

The advantages pertinent to these several means of lubrication are quite apparent to an industry such as the automotive, where every unit in the plant must function at maximum efficiency in order not to disrupt production schedules.

Broadly speaking, where oil is involved, these methods can be classified as flood or measured lubrication, according to the method of oil delivery.

MEASURED LUBRICATION

In this category will fall the mechanical force feed lubricator, as well as centralized pressure lubrication systems.

The Mechanical Force Feed Lubricator

With this device not only is one-time lubrication involved, but furthermore, oil is delivered in as nearly as possible the requisite amount to meet the actual requirements of the moving parts. With due care when installing and proper adjustment of the rate of oil feed, such lubricators are dependable and decidedly economical.

There is a further advantage in that by virtue of the fact that such lubricators can be readily driven by the machinery which they serve, they can be made to function only when the latter is in operation, and then only at a proportional speed. In other words, the higher the speed of operation, the more oil will be delivered. The pumping capacity and rate of oil flow is therefore variable. As a result, such a lubricator will automatically start or stop with the machine to which it is attached.

Equipment of this nature has been very successfully applied to a wide variety of machine tools where it is practicable to drive the lubricator by direct connection from some external moving part. This can be brought about by a link mechanism, an eccentric located on some rotating element, through belt connection from the machine itself, or by the use of an electric motor and speed reduction mechanism.

There is more or less of a limitation, however, involved in the use of a mechanical force feed lubricator for certain types of large machines, in that the capacity is oftentimes comparatively small in contrast with a flood circulating system, hence requiring more frequent filling. On the other hand, this will depend upon the extent of operation, the number of oil feeds and the rate of delivery. This latter must be worked out in actual practice, accord-

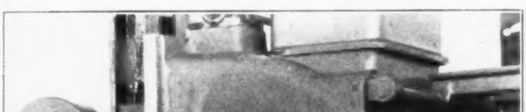
ing to the requirements of the parts to be lubricated, and the nature of the oil being used.

Operating Pressures Should be Studied

In the selection of virtually any means of pressure lubrication, it is important to have at least an approximate idea as to the operating pressures which will prevail between the moving elements. This is especially true in the case of mechanical force feed oilers. Where circulating flood lubrication is involved, volume in company with the pump pressure can be depended upon to maintain the necessary lubricating film between the wearing elements. With the mechanical force feed oiler, on the other hand, pressure alone is involved, for as already mentioned, the principle of operation is to deliver oil in as nearly as possible the right amount to maintain effective lubrication and economical operation.

As a result, pump pressure should not vary to any wide degree, nor should the lubricator be allowed to run dry, otherwise lubrication would cease in a comparatively short time.

It is interesting to note, in this regard, that

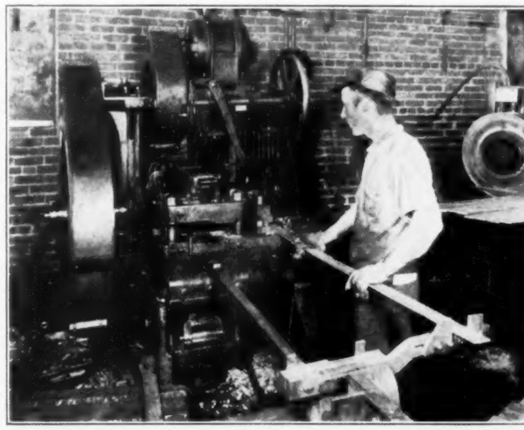


Courtesy of The Bullard Company

Fig. 2—Exterior view of a vertical turret lathe showing lubricator and piping to insure constant flow to all parts. In this machine all gears are enclosed.

where desirable a central source of supply can be employed. In other words, it is practicable to reduce the labor of filling by bringing this about through a suitable filling line run from the main supply tank. It is also practicable to install a steam heating coil in the bottom of such a lubricator.

In certain installations this latter will be a decided advantage, especially where machines may be exposed to low atmospheric temperatures. In such cases means for preheating the



Courtesy of McCord Radiator & Mfg. Co.

Fig. 3—A spring eye forming machine for the manufacture of automobile springs. Note that this device is served by a mechanical force feed lubricator. This process involves the preliminary heating of spring steel to red hot; the ends are then formed as desired.

oil prior to delivery will be desirable, otherwise it might easily become so sluggish as to cease to flow through the pumping elements or feed lines. This would be especially true where comparatively high viscosity cylinder oils are involved.

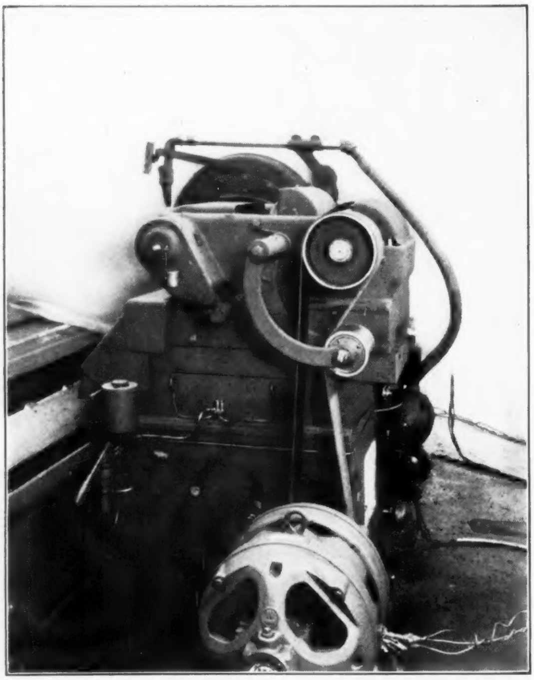
Nature of Construction

The typical mechanical force feed oiler consists of a bowl or reservoir of varying capacity ranging normally from one pint to two gallons. Within this reservoir, or attached thereto, is the pumping element or block. To this latter is attached the operating ratchet, clutch or belt connection.

The design of pump employed will depend upon the type of lubricator. In general, it will involve a piston or plunger. According to the service required, quite a number of such pumping units can be embodied in the one lubricator. Furthermore, this device can be divided into two or more parts so that more than one grade of oil can be delivered by the same lubricator. Where this latter prevails, however, care must be observed in filling, in order to make sure that the right oil is always put in the proper compartment.

Actual operation of the pumping element is brought about by an eccentric or cam located usually within the reservoir. It receives its motion through the exterior operating mechanism such as the ratchet. It is practicable to arrange the design so that each pumping unit

will operate independently, and capable of individual regulation. In order that the extent of lubrication, or rate of pumping can be observed, oil is delivered from the pump unit through a suitable gauge glass or sight feed device. The purpose of locating this latter in the discharge line is, of course, to enable observation of oil flow after it leaves the lubricator.



Courtesy of Norton Company

Fig. 4—View of a grinding machine equipped for centralized pressure lubrication of the wheel slide ways by means of the Bowen "one shot" system.

Centralized Pressure Lubrication

Another interesting phase in connection with pressure lubrication has been the development of a means of centralized lubrication which functions by virtue of a central control, all wearing parts so served being flushed and supplied automatically with oil from a central reservoir. By locating this latter adjacent to the machine to be lubricated and within ready reach of the operator and equipping it with a suitable plunger which operates the pump, lubrication of all parts connected thereto becomes but a matter of pressing a button, pulling the plunger, or turning a wheel whenever necessary or recommended by the builders, according to the operating conditions involved. In such a system the amount of lubricant fed is restricted to as nearly as possible the theoretical lubricating requirements of the respective bearings.

The fact that certain bearings will vary from others in regard to their requirements renders it necessary to provide for some arrangement of regulation or control of flow. Practically, this amounts to a metering of the lubricant in terms of drops. It can be brought about either by proper individual construction of the drip plugs, which on such equipment are also known as control outlets; by use of a control device located at the base of the pump, or by the installation of suitable adjusting manifolds at salient points in the system.

Properly installed, such systems are claimed to be relatively fool-proof, exceedingly simple to operate, and an insurance that clean oil will be delivered to the respective bearings. It is essential, however, that all parts be of rigid construction and capable of withstanding jars, shocks and temperature fluctuations, for while piping, etc., is guarded wherever possible it is relatively impossible to absolutely protect all parts from the chance of contact with external materials.

It is interesting to note that the possibility of entry of dust into such a system is quite as negligible as in a pressure grease lubricator. To further insure that clean oil is used, however, suitable filtering media, such as a felt pad or screen is employed, which will normally effectively remove any foreign matter that may have entered the oil in the course of storage or handling prior to usage; although lubricating oils as received from, or delivered by, reputable oil refiners can be relied upon as being free from foreign matter.

Pulsating Control

By use of the principles of pulsation and a suitable pressure control valve to regulate the oil flow, the necessity for manual operation, however, can be done away with. The lubricator itself is driven by belt or gear connection from any rotating part of the machine to be served. This is a decided adjunct where an extensive number of bearings are to be served, for the entirely automatic feature eliminates the possible factor of human error, the only alteration required occurs when the oil reservoir is to be filled, or any individual feeder adjusted.

In such a system the oil is fed only during a pulsation or high pressure period in the cycle of pump operation, control being maintained by a suitable plate valve arrangement. An added feature is the practicability of flushing the entire system under the prevailing pressure at the high pressure period, by pressing down a suitable flushing button which is a part of the pump unit.

CONTINUOUS LUBRICATION

Continuous, or flood lubrication, involves a directly opposite theory to intermittent, or measured lubrication, inasmuch as the bearings, etc., are literally flooded with an excess of oil, over that which is absolutely requisite for proper lubrication. The function of the oil is therefore to act not only as a lubricant, but also as a cooling medium to carry off any frictional heat that may be developed in the bearing under operation.

This flood of lubricant also keeps the bearing surfaces free from dust, dirt and metallic particles, to reduce the tendency toward abnormal wear or scoring of the shaft or bearing.

In certain installations the oil from a continuous oiling system can be drained to some central point of collection from which it may be removed when desired, and filtered or centrifuged in order to effect purification.

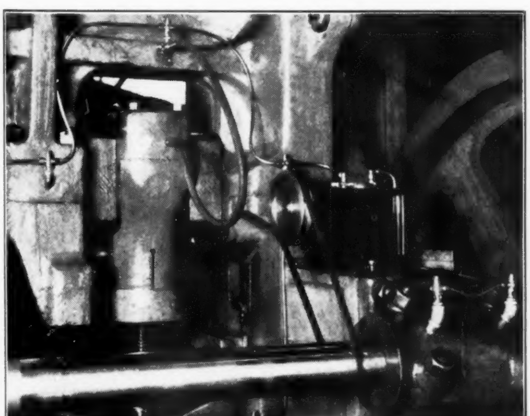
Continuous oiling may be broadly grouped into two classifications, i.e.,

1. Splash lubrication, and
2. Force feed lubrication.

Splash Systems

Splash lubrication is adaptable where the crankcase or oil sump is completely enclosed and the entire system is oil tight. In general, splash systems have some provision installed on the crank for picking up the oil from the base of the machine and transmitting or throwing it to the points to be lubricated.

The essential idea in splash lubrication is to



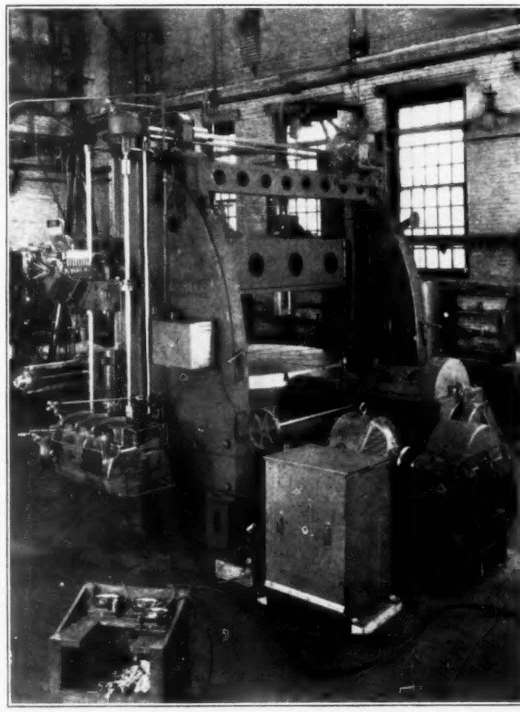
Courtesy of Rivet Lathe & Grinder Corp., Blanchard Lubrication Division

Fig. 5—Showing the Blanchard pulsating oiling system applied to a metal press. Note method of driving the oil pump.

maintain a suitable supply of oil in the crankcase in order that the crank or its oil dipper will never miss the surface of the oil.

In equipment lubricated by splash systems a quick water and sediment separation is imperative. The viscosity of the oil in a splash system should, therefore, be as low as is consistent with requirements, in order to insure rapid precipitation.

Few lubricants receive any harder service than those involved in systems of this type,



Courtesy of Bowen Products Corp.

Fig. 6—A Sellers Boring Mill equipped for centralized pressure oiling. Note the oil supply tank, pump and distribution piping.

since they are used over and over again, frequently without purifying or external cooling, as a result the capacity of the reservoir should be sufficient to allow the oil a certain period of rest.

Pressure Circulating Systems

Effective lubrication can also be brought about in a most dependable manner wherever it is practicable to employ a built-in system of lubrication. In normal practice such means of lubrication embody the principles used in automotive practice, wherein an oil tight reservoir, a suitable gear or chain driven gear pump and a simplified system of oil distribution piping are involved.

In a pressure circulating system the oil is forced into the bearings at pressures ranging normally from 5 to 15 pounds per square inch. This may be obtained either by making use of the action of gravity or employing oil pumps.

Where the first is involved suitable storage tanks are located at a sufficient elevation above

the bearings to produce a head corresponding to the required pressure.

In the second case an oil pump is installed, the oil being passed in a continuous cycle through the bearings, and then filtered and cooled, etc.

Lubricants used in such a system have their requirements controlled to a large extent by operating and constructional conditions. When the system includes ample purifying and circulating capacities the oil will be subject to comparatively light duty, inasmuch as bearings are continually washed out and there is opportunity for dirt and water to precipitate. Also, as there is an adequate and continuous flow of lubricant it will be generally unnecessary in such a case to select an oil capable of standing extreme temperatures or pressures.

It must be remembered that the lighter the oil the lower its internal friction will be. In fact, the two essential requirements are that the oil shall not emulsify nor contain any corrosive acids. Emulsification would clog the system, while acids would cause deterioration of the piping, filters, settling tanks, bearings, etc.

Ring and chain oilers are used to a certain extent in production service, and involve flood lubrication within the ability of the rings or chains to transmit the oil to the bearing. The same conditions hold for lubricants for this type of service as have been mentioned under splash lubrication.

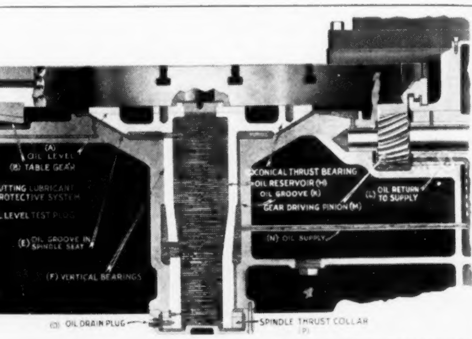
Essential Requirements

The selection of machine tool lubricants depends largely upon the method of application and the duty involved. In general, however, there are certain definite requirements which the oil must possess, i.e.,

1. Sufficient body or viscosity to prevent metal-to-metal contact of the surfaces to which it is applied, but not so heavy as to produce high internal friction.
2. An ability to flow readily when low service temperatures are involved.
3. Ability to stand up under continued service without any excessive tendency toward decomposition or gumming.
4. Ability to meet special service requirements, such as quick water separation, a low degree of vaporization, and the least tendency toward emulsification.
5. Freedom from impurities which might prove injurious to the system.

SPEED REDUCTION GEARS

In view of the importance of speed control in machine tool operation and the fact that frequently intricate gear trains are involved, the matter of lubrication of these latter must also be given careful attention, for it is absolutely essential that they function dependably, with a minimum of noise and power consumption at all times.



Courtesy of The Bullard Company

Fig. 7—Details of lubricating system for the table drive and spindle mechanism in a vertical turret lathe. Oil is maintained at a constant level, a continuous stream flowing into the reservoir, and by the overflow, lubricating the table gear and pinion as well as the essential bearings. By specially designed guards dust, chips, or cutting compounds are prevented from contaminating the lubricating oil.

Among the most interesting examples of gear installations on tools adapted to mass production are those involved in the lathe, planer and the milling machine, for the prevailing operations require the speed of the cutting element to be considerably lower than the speed of the driving motor. There will also be the necessity for certain speed variation, hence a number of speed reductions are usually found in the average machine.

Lathe Operation

In lathe operation power is transmitted to the spindle through a train of speed change gears inclosed in the head. In addition, quick change gear feeds may be used for operation of power feeds; back gears are installed on certain types of engine lathes; and bevel pinions and gears are found in certain lathe aprons for the purpose of reversing the direction of feed.

Efficient operation of such elements is based primarily upon effective lubrication. This has been fully realized by the progressive machine builder and as a result speed change gears at least are usually equipped for bath or splash lubrication. Not only do these methods insure against the possibility of abnormal wear but also they render operations relatively noiseless and preclude the occurrence of back-lash. An added advantage is derived on account of the fact that usually the one lubricant can be made to serve both the gears and their shaft bearings.

In most machines the gears are comparatively small and so carefully designed, cut and

aligned that unless excessive bearing wear takes place, lubrication can be effected by means of a relatively fluid lubricant, which will have sufficient viscosity to prevent metallic contact between the gear teeth and still be light enough to penetrate effectively to all the bearings. For this purpose the machine oil usually adaptable to bearing and slide lubrication should be suitable. As a rule a viscosity of from 300 to 400 seconds Saybolt at 100 degrees Fahr. will meet requirements in a satisfactory manner.

In the case of vertical or larger types of horizontal lathes, however, a heavier bodied oil may be advisable for certain of the larger gears. This will be especially true where the gears are enclosed, but have their bearings so located without the gear case as to permit of independent lubrication.

In such installations, a viscosity of from 120 to 200 seconds Saybolt at 210 degrees Fahr. may be advisable, depending on the closeness of mesh and whether back-lash is prone to occur.

It must be remembered, however, that while a heavier lubricant will eliminate a certain amount of the noise of operation and the pounding and hammering due to back-lash, especially when speeds are changed, the use of too viscous a product might readily involve serious power losses on account of the added friction developed by the gears moving through the more or less inert bath of lubricant.

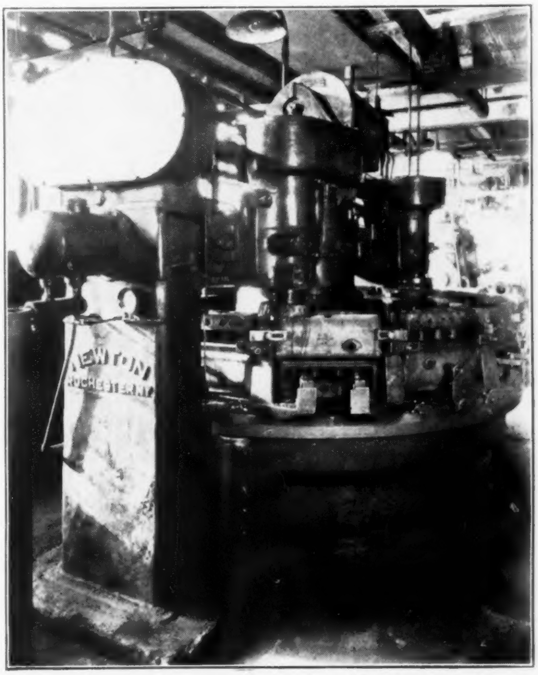
All machine gears, however, are not so enclosed as to permit of bath lubrication. Where exposed, they must therefore be lubricated by direct application of the lubricant to the teeth.

In service of this nature, the lubricant must not only be sufficiently viscous to preclude the occurrence of metallic contact between the teeth, but also it must be so adhesive as to stick tenaciously to these latter and resist the action of centrifugal force. Certain types of greases are capable of meeting the lubricating requirements, but their adhesive characteristics are frequently low, rendering them readily subject to throwing off. As a result, considerably more attention to their application would be necessary.

Straight mineral gear lubricants, on the other hand, overcome this difficulty and meet both requirements admirably. Hence they are generally preferred for all such exposed gearing. In viscosity they should range in the neighborhood of 1000 seconds Saybolt at 210 degrees Fahr., according to the tooth pressures, the temperatures of operation, and the prevailing speeds.

Planer Drives

The gears on the modern planer are, in turn, generally regarded as being the most important parts of the machine, for their primary function is to drive the table. In part, this is



Courtesy of Lubrication Devices, Inc.

Fig. 8—View of an 8 spindle rotary milling machine, equipped for automatic lubrication at 42 points, by means of a central gun, located at the side of the machine.

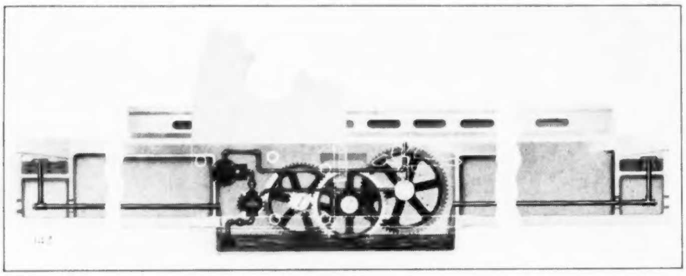
the reason why certain authorities classify planers according to their drive; i.e., according to whether they are spur, helical or worm geared.

Either the spur or helical drive is usually preferred by the machine tool designer today. Both involve essentially the same principles of operation, the only real difference being in regard to the design of the gear teeth. Certain builders of helical gears claim that this type of tooth is not only stronger for the same width of face and pitch, but also that it permits of more complete rolling contact, thereby reducing a certain amount of the wear which sliding friction might involve.

In construction, a planer drive consists of a rack which extends over the length of the entire under side of the table. With this rack the "Bull" or main gear of the driving train meshes. The intermediate set of gears which compose this train serve to bring about the necessary speed reductions from the driving element.

The arrangement of these gears is interesting due to the fact that quite a difference exists

between the cutting and return speeds. As a rule, the latter will be from two to four times the former, depending upon the size of the machine and the extent of cutting which may be necessary. In the worm drive planer a worm takes the place of the "Bull" gear; the table rack, however, remains the same.



Courtesy of The G. A. Gray Company

Fig. 9—Phantom view of a modern planer oiling system. Note that centralized oiling of bearings, gears, and V's, is provided for in this machine. Details of the lubricating system are clearly shown.

As a result of the prevailing construction, gear lubrication is regarded by many as the salient feature of efficient planer operation. The occurrence of rolling and sliding friction between the respective teeth as they pass into and out of mesh has already been mentioned. Theoretically, this would take place whether the gears were run dry or not. Actually, however, the continued occurrence of solid friction would tend to supplant rolling friction with sliding friction. Wear would thereby increase proportionately.

The substitution of fluid friction for solid friction, which is brought about by the use of a suitable lubricant which will permit of the formation and maintenance of the proper film over the gear teeth, will enable rolling contact to take place as originally designed for, unless faulty operation occurs, such as the gears working out of alignment.

Wherever gear lubrication must be carried out independently of the V's and bearings in the planer, the type of gears and their mode of operation must be taken into consideration, just as has been explained for the lathe. Therefore, lubricants as specified or used for these latter will be equally satisfactory if applied to the planer gears. The tendency is more and more to enclose all such gearing in an oil tight housing; not only does this reduce the hazards of operation, but it enables more effective gear lubrication, and oftentimes eliminates the necessity for using the heavier lubricants so essential to exposed gears.

Milling Machine Gears

Splash and bath lubrication of gears, and frequently many of the bearings, is also used on certain types of milling machines.

Such systems are particularly adaptable to column mechanisms, for with the gears of the drive shafts running submerged in oil, a sufficient amount of this latter is splashed to all parts of the column to effectively lubricate the bearings.

Here, however, the lubricant does its work under relatively low pressure, volume being relied upon to maintain the requisite oil films. Therefore, whereas a machine oil of perhaps 300 to 400 seconds Saybolt at 100 degrees Fahr., might suffice in a pressure oiling system, a heavier product even approximating a low viscosity mineral cylinder oil might be necessary for splash or bath lubrication.

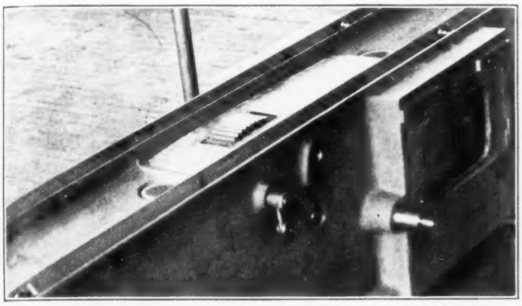
Conveyor Mechanisms

Withal the speed and productive efficiency of the average machine tool, in certain phases of industry, notably the automotive, means of conveying plays a most important part. The conveyor, in fact, is the coordinating element between the various departments or stages in virtually any branch of mass production, for products once passed through a machine must be moved away just as rapidly as the raw material is delivered. This is especially true where large work is being handled; smaller stampings, on the other hand, may frequently be discharged to containers and these latter moved only when filled.

Where work must be handled between floor levels or successively from one machine to another the belt or chain conveyor is the essential means of transportation. While the moving parts of such equipment are chiefly bearings, there exists somewhat of a variety of these latter. As a general rule, they are subjected to comparatively intensive duty, hence their protection by effective lubrication is an important detail in plant upkeep.

From an external viewpoint, the average conveyor belies the importance of its bearings. Apparently it is able to function under a wide variety of intensive operating conditions, and frequently dust, dirt or abrasive metallic particles do not seem to affect its ability to operate; on the other hand power consumption may be markedly increased. For this reason

the bearings customarily used in conveyor service are among the most accurately designed parts in the field of materials handling. In particular has effort been devoted to devising means to prevent entry of non-lubricating, abrasive matter.



Courtesy of Pratt and Whitney Co.

Fig. 10—View showing top construction of a planer bed, note cover over gear opening, and the oil strainers.

This in itself has been an interesting development, for it has brought many heretofore skeptical operators to a realization of the fact that lubrication can only be assured by continued maintenance of the lubricant in a sufficient state of purity.

ANTI-FRICTION BEARING PRACTICE

This thought has been particularly noticeable in the design of anti-friction conveyor roll bearings. In fact, in a study of the application of the anti-friction bearing to the machinery discussed in this article, its consideration in connection with conveying equipment will most completely cover its use.

Factors Involved in Development

Anti-friction bearings are of either the ball or roller type. Their development as a means of shaft or journal support has been extensive where such requirements as positiveness in action, and maximum reduction in friction, space occupied and attention from a lubricating point of view must be observed.

Contrast of Operating Principles

The anti-friction bearing is distinctive as compared with the plain or sleeve type bearing, in that from an operating viewpoint it will be very much more independent of lubrication. In other words, its ultimate efficiency will not depend to any marked degree upon its manner of lubrication, for the function of the latter by means of either oil or grease is rather to protect the highly polished surfaces of the rolling elements, than to serve as a means of reducing friction, carrying journal loads or removing heat from the bearing.

In the plain or sleeve type bearing, on the other hand, regardless of the means of lubrication or the lubricant used, the ultimate speed that can be developed and the load that can be carried will depend upon how effectively the lubricating system maintains an adequate film of oil in circulation through the clearance spaces to remove frictional heat and prevent metal-to-metal contact of the sliding surfaces.

Extent of Friction Developed

The fact that the anti-friction bearing, whether it be of the ball or roller type, will normally involve a minimum of friction, will be an asset in its favor wherever the occurrence of wear may be a detriment to productive efficiency and accuracy. Rolling motion will obviously not be prone to give rise to as much wear as will sliding motion.

On the other hand, rolling motion in an anti-friction bearing must be maintained as perfectly as possible, for if it ceases in the case of any particular element, as a ball or roller, more or less sliding will occur, to the detriment of the contact surfaces of itself as well as the raceways. To an extent this would approximate the operation of a plain bearing from the viewpoint of the type of friction developed, but with comparatively negligible means of counteracting this, for the prevailing lubricant would in all probability not be able to maintain an adequate load-bearing film or remove such frictional heat as would probably be developed.

Constructional Features

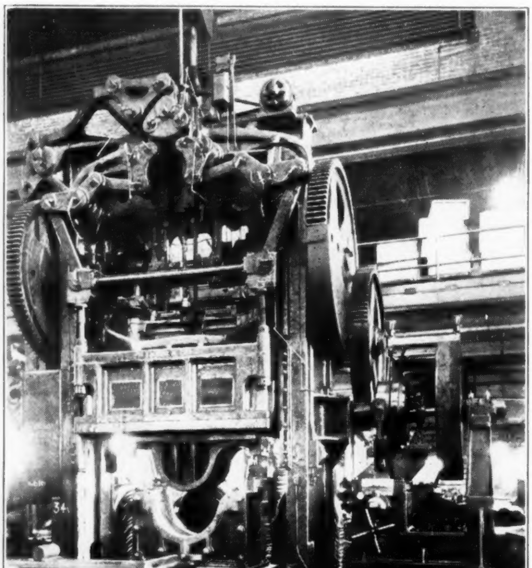
The modern anti-friction bearing will comprise a set of perfectly spherical balls or an ar-

Courtesy of Industrial Oil Equipment Co.

Fig. 11—A metal press in an automotive body plant equipped with "Gun-Fil" pressure grease lubricators. Note these latter on the central shaft bearing.

rangement of solid or flexible rollers. According to the nature of these elements they may be regarded as ball or roller bearings. In a discussion of lubrication, however, the collective term "anti-friction" bearing is preferred by many.

The essential difference between any particular makes of ball bearings will be in the design of the housing. In the roller bearing, however, the design of the roller will be the chief characteristic. In general, this will be either solid or flexible. The latter is always cylindrical in shape, the distance between the inner and outer raceways being uniform throughout the length of the roller. Solid rollers, on the other hand, may be either cylindrical or tapered according to the type or design.



Courtesy of Lubrication Devices, Inc.

Fig. 12—View of a toggle press for drawing automobile fenders. This machine is pressure grease lubricated from a central control reservoir, located at the base of the machine. Certain of the lubricant piping to the moving parts is clearly shown.

Manner of Housing

Irrespective of the nature of the rolling elements, anti-friction bearings in general will be carried or housed in much the same manner, i.e., in suitable containers comprising raceways or cages. In a typical design the inner race will fit on the shaft or journal, the outer being held by the frame or other rigid part of the bearing.

Between these so-called raceways are located the balls or rollers. These are kept in their proper position with respect to the races and to each other by the separator, cage or retainer.

Rotation of the shaft sets up a rotary motion between the rolling elements and the respective inner and outer surfaces of the raceways.

Rigidity a Factor

In view of the fact that rigidity and reduction of vibration are very essential where comparatively high speeds are involved, it is apparent that the anti-friction bearing, being practically devoid of any perceptible clearance to cause variations in shaft alignment, is a particularly adaptable device.

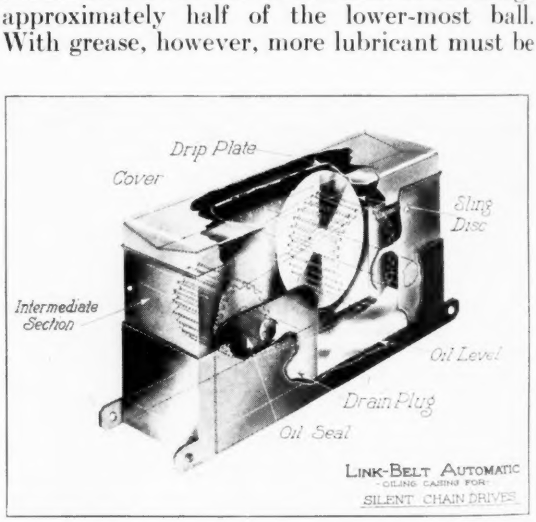
This very lack of clearance, however, imposes a distinct requirement upon any lubricant used in that it must be capable of developing and maintaining a film upon all contact surfaces which are in motion with respect to one another.

Ball Bearing Features

Ball bearings are claimed to involve less possibility of friction, to a certain extent, due to the fact that there is little or no end thrust involved. As a result the lubricant in such bearings serves more nearly the purpose of acting as a seal and metal-protecting medium.

In view of this fact, and to reduce the possibility of the development of abnormal internal friction within the lubricant, it is generally advisable to pay careful attention to the level of the latter.

As a general rule, when oil is used the housing should be filled to a level sufficient to submerge approximately half of the lower-most ball. With grease, however, more lubricant must be used, the housing being from one-quarter to one-half full.



Courtesy of Link-Belt Co.

Fig. 13—Showing details of a Link-Belt Socket Pillow block bearing construction in which Timken tapered roller bearings are employed.

All told, it is important to remember that contrary to the principles of plain bearing lubrication, the oil in a ball or roller bearing plays but a small part as a coolant. Therefore,

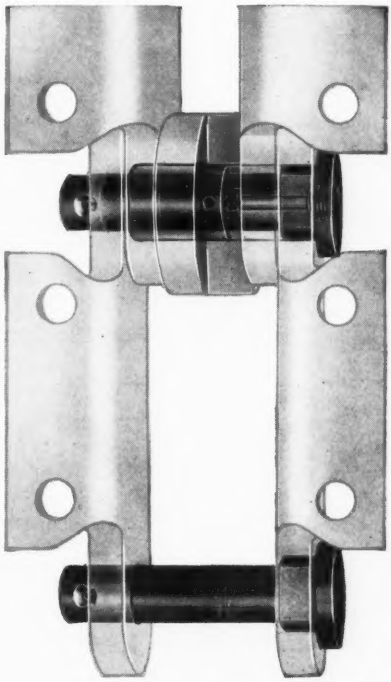
volume is a detriment rather than an advantage.

Roller Bearing Requirements

Roller bearing lubrication by means of oil is subject to much the same conditions as stated in connection with ball bearings.

Where end thrust may develop to an appreciable extent, however, due to difficulty in keeping the rollers in alignment, or where pressures or temperatures may be high, it is the opinion of certain authorities that it will be conducive to better lubrication if somewhat heavier oils are used. Under such conditions the use of straight mineral lubricating oils of as high as 750 seconds Saybolt viscosity at 100 degrees Fahr. are advocated. Even mineral cylinder oils of a high degree of purity may be necessary under conditions of extremely high duty, pressure or temperature.

The selection of heavier lubricants for roller bearing lubrication, however, should be carried out with the utmost care, for it is very possible to over estimate the conditions of operation, with the result that an excess of internal friction may be developed. As a rule, careful observation of bearing temperatures and cooperation with the builders and the oil industry will insure satisfactory results.



Courtesy of Link-Belt Co.

Fig. 14—Phantom view of a steel conveyor chain showing provision for pressure grease lubrication. In this way clean, fresh lubricant can be forced completely through each link connection to free the clearance space of used product, as well as to maintain a seal against entry of dust, dirt or grit.

Grease as a Lubricant

Wherever there is possibility of oil leakage, or under conditions of dust, dirt or dampness, it may be advisable to resort to grease as a lubricant.

Greases furnish better seals against the entry of dust, dirt and moisture, thereby serving to protect the polished surfaces of the bearing elements in a very satisfactory manner. Grease also can be very much more effectively retained in a non-oil-tight housing; on the other hand, dirt or grit that finds its way into a grease lubricated bearing has no means of settling out, but is always held in suspension, being carried back into the bearing repeatedly.

To meet the requirements involved most effectively, a grease for anti-friction bearing service should:

1. Show no tendency to separate in storage or when inactive within a bearing. Nor should this occur under moderate heating.
2. There must be no tendency toward hardening or decomposition.
3. There should be no constituent contained therein which might lead to corrosion, pitting or rusting of bearing elements. As a result this would prohibit usage or accidental entry of sand, resin, salts or abrasives of any nature whatsoever.
4. Nor should there be any component which might tend to cause the lubricating film to become sticky or the grease itself to gum.
5. And finally, the consistency involved should be suited to the operating requirements.

As a general rule, greases which are of comparatively average consistency will meet normal operating conditions where the lubricant must readily cover the entire surfaces of the balls or rollers and not tend to channel in the housings or raceways, as might occur with more viscous products of this nature which would have less of a penetrative ability.

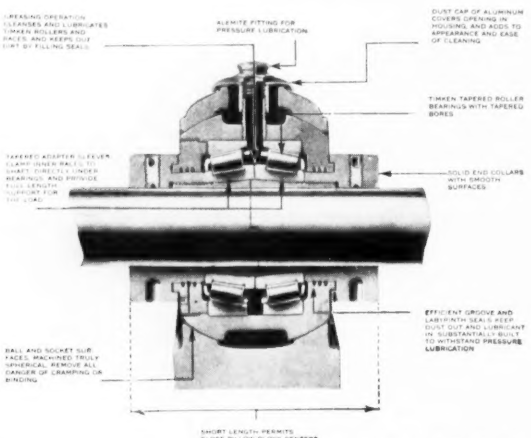
Flushing and Cleaning of Bearings

In order to insure the maximum of protection with any anti-friction bearing lubricant it is absolutely essential to keep the lubricating system as free from foreign matter as is consistently possible, according to the operating conditions and bearing construction.

There is always possibility of entrance of impurities, especially where the bearing is not properly sealed. It is a matter of decided importance for we can realize that continued churning of abrasive foreign matter with oil or grease, in intimate contact with highly polished balls, rollers and raceways, may ultimately prove the ruination of the bearing and its respective elements.

In view of the fact that it is not always pos-

sible to effect the requisite degree of sealing, or to depend upon the seal being in good order at all times, lubricating systems should be flushed and cleaned at periodic intervals. The frequency will, of course, depend upon the design



Courtesy of Link-Belt Co.

Fig. 15—Phantom view of the housing for a Link-Belt silent chain drive. Essential parts are clearly shown.

of the bearing, the type of seal, the lubricant used and the extent to which dust and dirt are present.

FACTORS GOVERNING CHAIN LUBRICATION

To insure proper and efficient lubrication of certain types of conveyor chains, it is decidedly essential that operating conditions be studied. In fact, only by combining a knowledge of such factors as speed, load, clearances and extent of bending or articulation can proper lubrication be determined upon.

Speed Conditions

Speed is important, since it involves the frequency of shock due to engagement of the chain links with the gear or sprocket teeth. In other words, the greater the speed the more frequent will be the shock on each link.

Whether or not shocks of this nature will be detrimental to lubrication will depend upon the load and constancy of operation. It is natural to expect that the rapid repetition of such shocks upon the bearing points of the chain will tend to force or squeeze the lubricating film out from between the bearing surfaces.

Bending or Articulation

The extent of bending or articulation of a conveyor chain will, of course, influence the amount of potential wear at the points of contact between the chain and the gears or sprockets. In fact, this is the chief cause of external wear, both of the chain and sprocket, notwithstanding that correct chain design endeavors to eliminate as far as possible this tendency towards friction and external wear, confining necessary rubbing or rolling to the joints.

Pins, bushings, rollers, etc., are therefore customarily built with adequate bearing surface to take up the usual strains. Still, a certain amount of external wear will be present at any event, and for this reason an adaptable chain lubricant should be capable of effectively serving both internal and external wearing points.

Clearance a Factor

Depending upon the existing clearances, the lubricant must have a certain amount of fluidity in order to be able to penetrate thoroughly throughout the entire link mechanism whether pins and bushings, rollers or rocker joints are involved. On the other hand, to adequately prevent external wear of teeth and chain a relatively heavy adhesive lubricant should be used, which will adequately resist the effects of centrifugal force and stick to the wearing surfaces. Such a lubricant will, however, frequently be too viscous to serve the internal bearings. Hence a compromise must be effected whereby sufficient viscosity reduction is obtained to meet one purpose, yet with the retention of adhesion as much as possible. Certain steam cylinder oils, or other reduced petroleum products have been proven to be the best bases for such a lubricant. Where necessary they can be blended to the desired viscosity with lighter, straight mineral products.

Foreign Matter a Detriment

When chains must be operated in the presence of heat, dust, dirt, chemical fumes or water, the duty imposed upon the lubricant will, of course, become all the greater. In such cases not only must it serve as a lubricant, but as well as a protective agent for the bearing surfaces.

Heat will thin down the lubricant frequently to a marked degree, while grit, dust, acids and moisture will tend to promote wear and corrosion. Grit and dust in particular, being of an extremely penetrative nature, will always tend to work into clearance spaces and immediately increase the wear. As a result, unless the lubricant is of the proper viscosity it will often become incorporated with such foreign matter and develop into an abrasive paste similar to a valve grinding compound.

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